GeoTrans, inc.
GROUNDWATER SPECIALISTS

NEWSLETTER

Woburn Toxic Trial

June 1987

Introduction

GeoTrans provided technical analyses and expert testimony regarding hydrogeologic issues on behalf of W.R. Grace and Co. in what has been referred to as the Woburn Toxic Trial. The trial resulted from a May 1982 lawsuit filed on behalf of eight Woburn families. The lawsuit alleged that family members had suffered serious health effects, including leukemia, as a result of exposure to contaminated water from Woburn public supply wells G and H. The May 1982 lawsuit and a subsequent lawsuit alleged that the Cryovac plant of W.R. Grace was one of three sources of contamination to the wells. The other two named sources were Beatrice Foods, which owned the John J. Riley tannery, and the Unifirst Corporation, an industrial dry cleaner.

Five chemicals were named as contaminants in the law suits: trichloroethylene, 1,1,1 trichloroethane, tetrachloroethylene, 1,2 trans-dichloroethylene, and chloroform. Prior to the trial the plaintiffs and the Unifirst Corporation reached settlement; therefore, two defendants remained for the trial. Due to the technical complexity of the case, the trial was divided into four phases. The first phase was to determine whether either of the two remaining defendants was responsible for the chemicals found in the public supply wells; the second phase would resolve whether any of the chemicals could have caused leukemia; the third phase would address other health claims; and the fourth phase would decide punitive damages. The two defendants were located in opposite directions from the wellfield; therefore, the principal technical issues were different for each. With respect to our client, W.R. Grace, the major hydrogeologic issues were:

- *whether chemicals could have traveled from the Cryovac plant and reached wells G and H by May 1979, the date the Massachusetts DEQE ordered the Town of Woburn to cease pumping from wells G and H;*
- *hydraulic connection between the Aberjona River and the aquifer which supplied water to the wells; and*
- *existence and evaluation of other possible contributors to the contamination found in wells G and H.*

Hydrogeologic Conditions

The Town of Woburn is located approximately 10 miles north of Boston and the wellfield is in the northeastern portion of the town of Woburn (Figure 1). The Cryovac plant is a manufacturing facility located in the upland area of the eastern edge of the Aberjona River Valley one-half mile east of the public supply wells. Wells G and H are located at the eastern bank of the Aberjona River between Olympia Avenue and Salem Street. Between these two streets the Aberjona River flows through a marsh which is approximately 600 feet wide. The Aberjona River is part of the larger Mystic River drainage basin and the surface water drainage area north of Salem Street is approximately seven square miles[1]. This large drainage basin encompasses what has been known since 1880 as the "Chemical District" of Woburn.

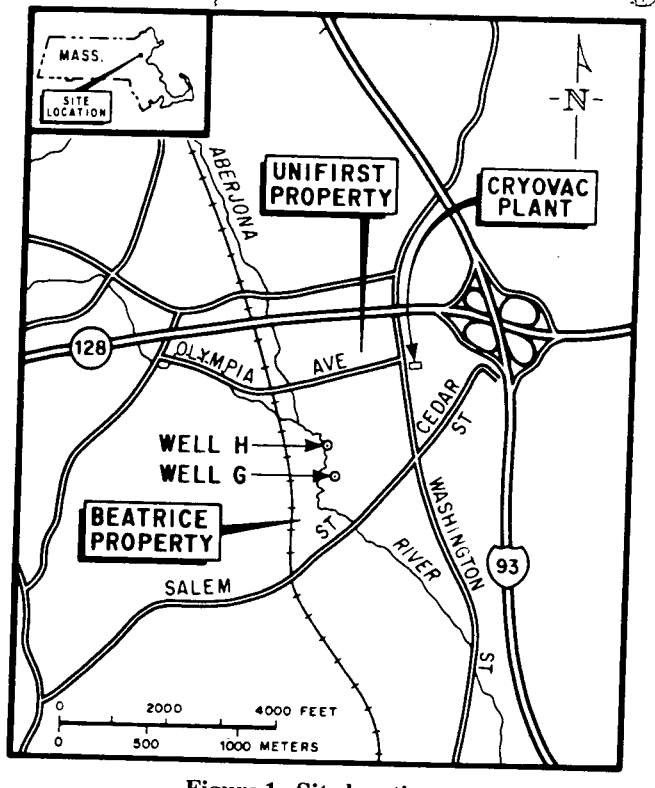

Figure 1. Site location map.

The general hydrogeologic conditions within the Aberjona River Valley are characteristic of a glaciated New England river valley. The river is found in the center of the valley and overlies a bedrock trough filled with glacial outwash deposits. The upland areas at the edges of the valley are typically underlain by glacial till and bedrock. A U.S. Geological Survey study[2] of the glacial geology of the

[1] Delaney, D.F., and F.B. Gay, 1980. Hydrology and Water Resources of the Coastal Drainage Basins of Northeastern Massachusetts from Castle Neck, Ipswich to Mystic River, Boston: HA-589.

[2] Chute, N.E., 1959. Glacial Geology of the Mystic Lake-Fresh Pond Area, Massachusetts, USGS Bulletin 1061-F.

Woburn area indicated that the Cryovac plant is located on ground moraine or till deposits of Wisconsinan age. More than 31 trench excavations and installation of 65 monitoring wells at the Cryovac plant by GeoEnvironmental Consultants confirmed the presence of a dense clayey till beneath most of the Cryovac property. These materials most likely represent lodgement or basal till.

The differences in the mode of deposition of the various materials found within the Aberjona River Valley result in a lateral gradation from low permeability material at the edges of the valley to high permeability material in the center of the valley. The low permeability of the lodgement till reflects the poor sorting characteristics and compressed nature of material deposited directly beneath several thousand feet of glacial ice. The higher permeability of the outwash deposits reflects the better sorting of materials by streams which flowed away from the edges of a retreating ice front.

Within the principal area of interest, groundwater flow directions are generally lateral from the edges toward the center of the valley. Near the center of the valley groundwater flow converges toward, and generally flows parallel to, the course of the Aberjona River. Under nonpumping conditions some of the groundwater flow discharges upward into the Aberjona River and becomes part of the surface water flow system. Figure 2 illustrates regional groundwater flow directions when wells G and H are not pumping.

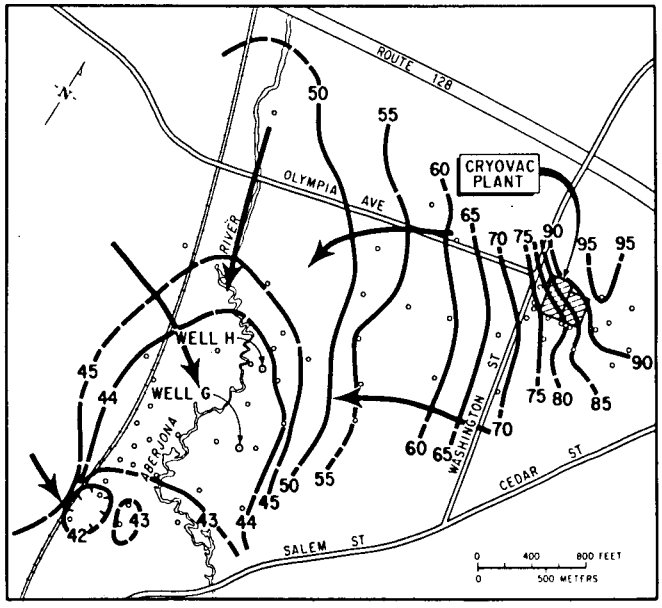

Figure 2. December 1985 water level map (ft above msl).

Model Analyses

A three-dimensional groundwater flow model was constructed to aid evaluation of hydrogeologic conditions in the vicinity of wells G and H and to assist in the analysis of groundwater flow directions and rates from the Cryovac plant. The groundwater flow code used in this analysis, HYPER-3D (Hydraulic Parameter Estimator in 3 Dimensions), was developed by GeoTrans staff. The code combines the USGS-3D code and the Gauss-Newton technique for nonlinear least squares parameter estimation. The flow model was calibrated under steady-state flow conditions using water-level data from 119 observation wells. Groundwater level and streamflow change measurements collected during a 30-day pumping test of wells G and H were used to identify the zones of influence and capture of the two wells and to calibrate the groundwater flow model under transient flow conditions.

A chemical transport model was used to evaluate whether chemicals found in groundwater beneath the Cryovac plant could have reached the two public supply wells by May 1979. The SWIFT II computer code was used to simulate the groundwater transport of chemicals. This public domain code was developed, in part, by GeoTrans staff to support the high-level radioactive waste disposal licensing requirements of the U.S. Nuclear Regulatory Commission. Water quality data from the 65 monitoring wells located on the Cryovac property were used to define the spatial distribution and magnitude of on-site groundwater contamination and to identify the probable on-site sources of that contamination. To be conservative in our analyses, we assumed that chemicals entered the groundwater system at a constant rate from the day the plant opened in June 1960. This simplifying assumption overestimated the potential for chemicals to reach wells G and H by May 1979. More than twenty alternative simulations were made to evaluate the sensitivity of model results to factors such as retardation, dispersivity, effective porosity, decay, recharge, and pumping. The results of the groundwater flow and chemical transport analyses supported the opinions that the low permeability sediments found beneath the Cryovac plant had a significant effect of limiting the migration of contaminants from the Cryovac plant toward wells G and H, and that chemicals from the Cryovac plant could not have reached the supply wells by May 1979.

Hydrologic Investigations

The U.S. Environmental Protection Agency is currently performing a Remedial Investigation/Feasibility Study (RI/FS) of the Woburn public supply wellfield. Part of that investigation includes performing a 30-day pumping test of wells G and H. The pumping test was conducted under the direct supervision of the Massachusetts office of the U.S. Geological Survey. The test was designed to identify the area of contribution to wells G and H, to evaluate the hydraulic connection between the Aberjona River and the aquifer, and to collect other information to support the feasibility study. The pumping rates from each well were identical to the maximum pumping rates for the wells when they were part of the Woburn public water supply system. Well G was pumped at 700 gal/min and well H was pumped at 400 gal/min. The pumping test was conducted between December 4, 1985 and January 3, 1986, and the data were made available to the public by February 1986. The data were important for analyses of hydrogeologic conditions in the Aberjona River Valley.

In addition to providing water-level data to assist in model calibration, the 30-day pumping test provided important information regarding the source of water pumped from wells G and H. Water-level measurements made at the end of the pumping test illustrated the elliptical shape of the cone of depression which resulted from the pumping of wells G and H (Figure 3). This shape reflects the heterogeneity of the unconsolidated glacial deposits, namely the differences between the permeable outwash materials, which are aligned parallel to the Aberjona River, and the low permeability till deposits which underlie the edges of the glaciated valley.

Streamflow measurements, made at five gauging stations before and during the pumping test, demonstrated that the Aberjona River was a source of groundwater recharge under pumping conditions. Prior to pumping wells G and H, streamflow in the Aberjona River increased by several hundred gallons per minute between Olympia Avenue and Salem Street. The increase in streamflow results from groundwater discharge to the river under nonpumping conditions. Within 24 hours of the start of pumping the streamflow change between Olympia Avenue and Salem Street was negative. The Aberjona River was losing water by induced infiltration in response to pumping. At the end of the pumping test the streamflow loss was approximately 600 gallons per minute (Figure 4).

In a public meeting held in the Woburn Town Hall in October 1986 (four months after the trial ended) the U.S. Geological Survey also reported that the results of the pumping test demonstrated that a substantial amount of the water pumped from the wells is induced infiltration from the Aberjona River and its associated marsh, and that under pumping conditions groundwater flows from the westerly side of the Aberjona River toward wells G and H. The pumping test results clearly demonstrate that analysis of possible past, or future, sources of contamination to the public supply wells could not be constrained to the immediate vicinity of the wellfield. The elliptical shape of the cone of depression, which was oriented parallel to the Aberjona River and extended several thousand feet north and south of the pumping wells, and the hydraulic connection between the groundwater and surface water system indicated that the industrial history of the Aberjona River Valley also needed to be considered to understand the possible sources of contamination to the wellfield.

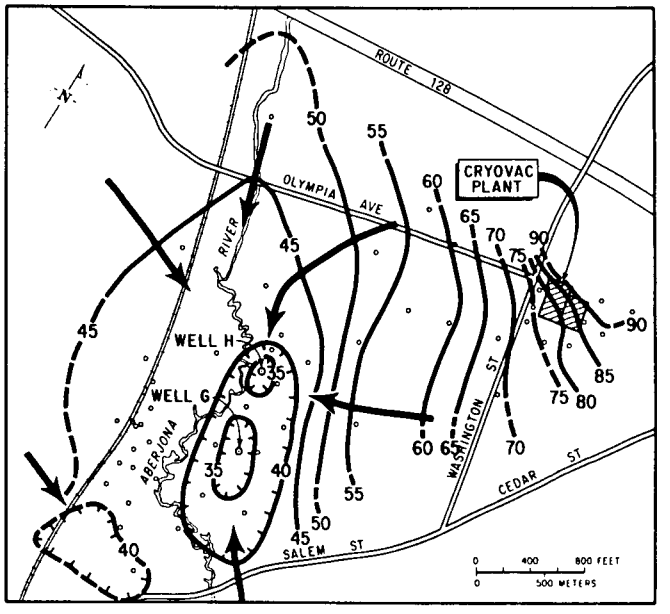

Figure 3. January 1986 water level map (ft above msl).

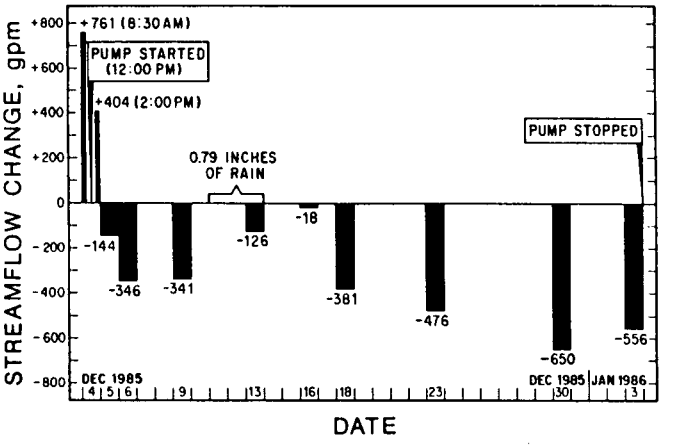

Figure 4. Streamflow change graph.

Trial Conclusions

In July 1986, the jury began its deliberations. Differences between the testimony of the two Expert Witnesses could not have been more extreme. The plaintiff's expert had testified that chemicals from the Cryovac plant reached the wellfield in concentration ranges from tens to hundreds of parts per billion before the first day of pumping in 1964. Our opinion was that chemicals could not have reached the wells from the Cryovac Plant by May 1979.

After eight days of deliberation the jury reached a verdict. With respect to Beatrice Foods, the jury found that the plaintiffs had failed to establish, by a preponderance of the evidence, that any chemicals from Beatrice property had reached the wells prior to their closure in May 1979. With respect to W.R. Grace, the Judge had already stricken, or indicated his intention to strike, from the case against W.R. Grace the chemicals 1,1,1 trichloroethane, chloroform, and tetrachloroethylene. Of the two remaining chemicals, trichloroethylene and 1,2, trans-dichloroethylene, the jury found that the plaintiffs had failed to establish, by a preponderance of the evidence, that W.R. Grace was responsible for contaminating the wells with 1,2 trans-dichloroethylene prior to well closure. The jury verdict concerning trichloroethylene was unclear and contradictory. As a result of the ambiguity of the verdict, Judge Skinner, on September 17, 1986, ordered a new trial.

On September 22, 1986, the Plaintiff families and W.R. Grace announced that a settlement had been reached.